DOCUMENT RESUME

ED 294 294 EA 019 769

AUTHOR Nigro, Kirk A.
TITLE Improving the Teaching of Science: An Overview of Recent Research.
PUB DATE Nov 87
NOTE 15p.; Paper presented at the Annual Meeting of the National Science Teachers Association (Pittsburgh, PA, November 5-7, 1987).
PUB TYPE Reports - Descriptive (141) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Class Organization; Classroom Techniques; *Educational Environment; *Expectation; Instructional Leadership; *School Effectiveness; *Science Education; Secondary Education; Student Attitudes; *Teacher Effectiveness
IDENTIFIERS *Effective Schools Research

ABSTRACT

From observation-based effective schools research, five essential correlates have been identified: (1) purpose; (2) measurement; (3) leadership; (4) expectations; and (5) climate. This paper briefly describes all correlates and then focuses on climate and expectations as applied to improving science instruction. Although climate originally referred to the physical comforts of a school or classroom, it came to denote the psychological environment--an environment conducive to learning. This concept can be further expanded by adding a planning dimension, including organization and management. Organization refers to things a teacher does (curriculum planning, activities, and strategies) before students are present. Management refers to things a teacher does (teaching and explaining and justifying classroom rules) after students have arrived. Both phases are essential and complementary. Hints are provided to ensure that classroom activities are satisfying and move along at a brisk pace. Sound instructional objectives and high teacher expectations are very important in science classes. Teachers must be careful not to discourage female students from pursuing an interest in science. There is a high correlation between attitudes and achievement. Teachers should be concerned about students' misconceptions about scientific concepts and their attitudes toward science. The best hope for encouraging students to consider science careers is to make their classes interesting, challenging, and meaningful. Proper classroom management techniques get students off to a good start. Included are 15 references. (MLH)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED294294

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.

Minor changes have been made to improve reproduction quality.

Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Kirk A. Nigro

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Improving the Teaching of Science: An Overview of Recent Research

Paper Presented at the
National Science Teachers Association Convention
Pittsburgh, Pennsylvania
November 5-7, 1987

Kirk A. Nigro
School of Education
Eastern New Mexico University
Portales, New Mexico 88130

SE 049 769

Improving the Teaching of Science:
An Overview of Recent Research

A great deal has been learned in the last fifteen to twenty years about what makes some teachers and schools more effective, in terms of learning outcomes, than other teachers and schools. Much of the original research began with the identification of certain factors, or correlates, which are present in schools that are instructionally effective (Brookover & Lezotte, 1979). Research studies over the years have been written by individuals who went in to schools and observed teachers and students as they went through their daily routines. These researchers did not attempt to experiment with what they observed; they only noted what they actually saw.

From this research, five correlates have been identified as necessary in effective schools: (1) purpose, (2) measurement, (3) leadership, (4) expectations, and (5) climate. Because it is beyond the scope of this brief paper to discuss all five correlates in detail, only climate and expectations will be dealt with; however, a brief description of the other correlates is in order.

The factor referred to as purpose simply means that all of the

educators within a given school agree that the primary mission of the school is learning and teaching. That is not to say that various extracurricular activities are out of order; rather, effective schools keep the primary focus on learning, student outcomes, and instructional matters.

Measurement is a factor in instructionally effective schools, whereby educators measure the results of student learning. It is inappropriate to design curriculum without knowing how much students know, how well they know it, and how much they have learned. In addition, it is also inappropriate for schools to make claims of effectivenss without specific measures to support their claims.

The factor known as leadership refers to the fact that the principal in an effective school acts as an instructional leader. Instructionally effective schools are led by strong leaders who are actively involved in the learning process.

The correlate we call expectations is a powerful one. Teachers should hold high expectations for students. Those who do not, may find that they are faced with a self fulfilling prophecy. Obviously there are teachers, as there are individuals in all walks of life, who may form expectations based on skin

color, ethnicity, and socio-economic status (SES), for example. If teachers hold low expectations for students in the aforementioned categories, they may send "messages" to the students, by way of a broad variety of behaviors, which "tell" the students that the teacher does not hold high expectations for them.

In effective schools, educators hold high expectations for students, believing that all students can master basic minimal skills, at the very least. Teachers are careful not to send messages to students that indicate otherwise. In the classroom, they are careful to seat low achieving children away from the back of the room. They do not wait less time for low achievers to answer; they provide cues when lows are attempting to answer; they provide genuine and personalized praise for work well done by low achievers. Brophy (1979) and others have done considerable research related to the appropriate strategies for teachers to employ when working with low achievers, and low SES students; his work is research that teachers ought to look at.

The correlate of climate is another major area of interest and concern for all teachers. At one time, climate was conceived of as being related to the physical comforts of a classroom or

school. It included such things as heating and cooling, ventilation and appropriate lighting. Later, climate began to include the concept of having an appropriate psychological environment--an environment conducive to learning. Those ideas have not disappeared, but rather, we now add to the concept of climate, organization and management.

Organization refers to those things that a teacher does before students are present. For example, we would include the planning of curriculum to be covered, the activities and strategies to be employed, and the rules and regulations that will be used by the teacher, as well as the plans for the physical arrangement of the classroom. Effective teachers engage in a tremendous amount of planning in all of the aforementioned areas, in order to be as effective as possible.

Management refers to those things that a teacher does after the students have arrived. Of course, the organizational phase and the management phase are tied closely together. If a teacher has not devoted considerable time to organizing the classroom, the management phase will be filled with problems. One cannot say too much about the importance of planning during the organization stage in order for management to be smooth.

Perhaps one of the more important parts of planning is to make preparations for the physical layout of the classroom, which would include various layouts that might be utilized for a variety of activities. For example, during normal instruction a conventional layout might be used; during class discussions, desks might be set up in a horseshoe shape to encourage participation by all students. Naturally, during hands-on activities (experiments and the like), the seating arrangements might be quite different.

The physical layout of the room during experiments should be given considerable attention. Questions that teachers might ask themselves could include; where will materials and supplies be kept for maximum utilization by students; how will the materials and supplies be given out to students; will students work individually or in groups; will the teacher be able to monitor all students continuously; what safety lessons need to be taught before the experiment starts; what special rules and regulations need to be in force during the experiment?

Another major part of organization concerns rules and regulations within the classroom. Teachers should spend considerable time developing these. Without good rules and

regulations, a classroom can be rather chaotic. During the management phase, the rules need to be taught, explained, justified and enforced from the first day of school. It helps to have students involved in the development of rules, but of course, all final decisions are up to the teacher. If students are involved in rule development, they feel some sense of ownership in them, and consequently, they may be more easily enforced. It is important to teach the rules; students are more likely to live within rules that they thoroughly know and understand. Enforcement from the first day is crucial, otherwise students will begin to believe that the rules really are not important; additionally, other statements made by the teacher may seem rather hollow as well.

Recent research devoted exclusively to science education has provided useful information for science educators. The findings of such research support and enhance the more general research into teacher and school effectiveness.

Providing a variety of activities in any classroom is appropriate, and science classrooms are no exception. Nearly three decades of research suggests that greater gains in a wide range of student outcomes at all age levels result from activity

based science programs over traditional programs (Bredderman, 1984). Specifically, Stallings (1982) says that science teachers need to provide varied activities during the class period and create a supportive envirommment. Not only research, but common sense and conventional wisdom tells us that students who are provided with instruction that includes more than lectures and seatwork will probably enjoy the class more, and may show higher learning outcomes, as well.

General research in teacher and school effectiveness notes that instructional objectives need to be appropriate for the student's level and that students need to know when they have been successful by receiving positive feedback (Murphy, et. al., 1982). Again, we find strong agreement between the general research of effective schooling and specific research in science education. Effective science classrooms appear to be those in which teachers make students aware of instructional objectives, and students receive feedback from their teachers related to those objectives (Wise & Okey, 1983).

We know that in classrooms where transitions from one activity to another are not smooth, discipline problems can develop with great rapidity. More specifically, Stallings (in Robinson, 1981)

stated that lessons should move along at a brisk pace and should allow for consistent success. It comes as no surprise that science teachers ought to provide for success. More general research in effective schooling has maintained the same thought for some time. We know that effective classroom management means that students know what is expected of them and are generally successful in what they are doing. At the same time, there should be little wasted time, confusion, or disruption (Sanford, et. al., 1983).

Science educators ought to be aware of another area related to expectations. There is a concern, shared by many, that female students are sometimes discouraged from pursuing an interest in science. In a study of six hundred students in grades four, five and six, Burke (1984) found that by sixth grade both male and female students agreed that the teacher would select a male as being the best science student in the class. Burke also found that the teacher was the single most important significant factor for encouraging success in science. With these thoughts in mind, it seems obvious that science teachers must not let any preconceived notions get in the way of quality teaching of science to both boys and girls. Here again, expectations and

self fulfilling prophecies enter the picture. The teacher who "tells" a female student, through behaviors such as asking the student few questions or allowing little time to arrive at a reasonable response, could needlessly be discouraging a potential bright science student.

In research conducted by Benjamin Bloom (1976), he found a correlation between attitudes and achievement. Further, he suggested that students who were consistently in the bottom twenty-five to thirty-five percent of their science class developed poor academic self-concepts and became convinced that they could not be successful in science. Effective classroom management and a positive climate should be created by science educators to develop students' positive attitudes, thus creating conditions for encouraging increased achievement.

Another concern should be shared, which is the fact that some students develop a dislike for science because they have misconceptions about the subject and their teachers do not take the misconceptions into account. In a study of fifth graders, Smith and Anderson (1984) found that fewer than one quarter of the students studied learned the scientific concepts being taught when the teachers did not modify their instruction to take

misconceptions into account. After materials were modified and teaching behavior was altered, learning improved. The only way science teachers can be sure that students are not laboring under false misconceptions is to continuously assess student learning outcomes. This may be done by way of either formal or informal assessment; whatever the methodology employed, science teachers need to continually question students to be sure that they have not simply used rote memory to indicate comprehension, but that they truly do understand the concept being taught.

One last area deserves attention. We should all be concerned about what students think of science. Those who dislike science as elementary or junior high students are not likely to suddenly change their attitudes toward science when they reach high school. Jacobson and Doran (1986) surveyed two thousand ninth grade students and found that only two percent wanted to become science teachers. This is an alarming figure. If American technological advances are to continue, we must have young people who are interested in science, whether as scientists, or as science teachers. The science teachers of today have a tremendous influence on who will become the science teachers of tomorrow.

I believe the best hope for encouraging students to become interested in a career in science is to make their classes interesting, challenging and meaningful. By properly applying the techniques of classroom organization and classroom management to science classes, the teacher is off to a solid start. Then, by keeping the notion of expectations firmly in mind--and adjusting teaching accordingly--students are far more likely to appreciate what science has to offer.

We cannot afford to loose potential scientists, for no good reason. After the Soviet Union launched Sputnik in the 1950's, we showed great concern for science and science education. We should have learned a lesson at that point. Let us not have to relearn the lesson. Science teachers can encourage science students by applying the research learned from teacher and school effectiveness.

References

Bloom, Benjamin. (1976). Human Characteristics and School Learning. New York: McGraw Hill.

Bredderman, T. (1984). The influence of activity-based elementary science programs on classroom practices: A quantitative synthesis. Journal of Research in Science Teaching, 21(3): 289-303.

Brookover, W. and Lezotte, L. (1979). Changes in school characteristics coincident with changes in student achievement. East Lansing: Michigan State University, College of Urban Development.

Brophy, Jere. (1979). Teacher behavior and its effects. Journal of Educational Psychology, 71(6), 735.

Brophy, Jere. (1981). On praising effectively. Elementary School Journal, 81(5), 269-278.

Brophy, Jere, & Good, T.L. (1974). Teacher-Student Relationships: Causes and Consequences. New York: Holt, Rinehart & Winston.

Burke, P.Y. (1984). A study to determine the trends in attitude toward science among fourth, fifth and sixth grade male and female students. Dissertation Abstracts International, 44(9), 2663-A.

Jacobson, W., and Doran, R. (1986). What do our ninth graders think of science and school? The Science Teacher, May 1986, 59-61.

Murphy, J., Weil, M., Hallinger, P. and Mitman, A. (1982). Academic press: Translating high expectations into school policies and classroom practices. Educationa Leadership, 40(3), 22-26.

Robinson, James. (1981). Research in science education: New questions new directions. ERIC Document, ED 209 075.

Sanford, J., Emmer, E. and Clements, B. (1983). Improving classroom management. Educational Leadership, 40(7), 56-60.

Smith, E.L. and Anderson, C. W. (1984). The planning and teaching intermediate science study: Final Report. ERIC Document, ED 250 161.

Stallings, J. (1982). Classroom research: Implications for mathematics and science instruction. ERIC Document, ED 209 075.

Stallings, J. (1984). Effective use of classroom time. ERIC Document, ED 251 973.

Wise, K. and Okey, J. (1983). A meta-analysis of the effects of various science teaching strategies on achievement, Journal of Research in Science Teaching, 20(5), 419-435.